Autocalls products in Asia Exotic Index Trading desk: Risks review, current protections, hedge proposals

Abstract

Modeling and hedging autocalls

The cancellation feature on an autocall explains why this product is model-dependent: when spot moves, it needs dynamic rehedging with vanilla options, forwards, forex options… and requires a model which correctly combines market data dynamics, either calibrated on tradable products, either calibrated on realized covariances.

A multi-underlying local volatility model (associated with stochastic rates, quanto adjustment and proportional dividends) deals correctly with combined diffusions of stocks, rates and dividends. But it leaves aside diffusions of equity volatility, forex volatilities, correlations between equities and quanto corelations, and, of course, combined diffusions of these market data against the spot.

If we call Vanna the 2nd derivative over spot and above data, the adjusted valuation of this model-dependent pay-off consists as the integrated (over time) product between Vanna and the spread between realized covar and model covar:

$$"All\_Vanna"\_P\&L_{0\to T} = \int_0^T \sum_{stock_i,\alpha_k} \frac{\partial^2 P}{\partial S_i \partial \alpha_k} S_i [RealisedCovar(\ln(S_i),\alpha_k) - ModelCovar(\ln(S_i),\alpha_k)]$$

Miscarries and losses occurred in the past in exotic books are coming **from this valuation adjustment term.**

Spot/volatility losses in 2012 on the NKY and Spot/convexity losses in 2015 on SX5E exhibit perfectly the cost of this valuation adjustment which rises sharply when spot enters the "high vanna" zone (roughly 70%-110% of the recall barrier).

Losses due to inversion of vega on the NKY in 2002 or HSCEI in 2015 look more as a "tail behavior" of markets partially linked to dynamic rehedging and a phenomenon of short squeeze.

Coping with Autocall valuation adjustment: current hedges and proposition of additional ones

Of course, the book is already protecting these scenarii.

The trading team uses wide barrier spreads which will be reduced when spots are coming close to barriers, in order to deliver a one-shot profit to compensate losses that occur in these zones.

Another tool is to mark the non-diffused market data (forex volatilities, quanto correlations and equity/equity correlations) on high water marks. It gives some room to avoid constant remarking when spot moves and consequently important vanna losses. Full dehedging of products on their highest valuation reduces greeks and offers opportunistic rehedging when spot decreases.

Eventually, the desk buys convexity by selling downside put spread ratio in order to hedge tail risks.

We propose to put in place two new kinds of hedge, in order to improve further the ones already implemented.

Through a dedicated over-coupon which emulates both in valuation and in greeks the critical "high vanna" zone to compensate potential losses.

We recommend to accelerate convexity buying, either with Varswaps or downside puts.

	High Vanna zone spot in [70%-110%] painful Vannas miscarry	**Crisis zone - Tail behaviours** spot below 60% strong volatility/convexity rising
Current hedges	wide recall barrier spreads market data overmarking	wide Down&In activation barrier spreads buying convexity through selling of put spread ratio
	Full dehedging of products on their highest valuation	
Proposition of additional hedges	booking of a dedicated overcoupon selling near-the-money skew	buying more convexity: varswaps or downside puts

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Summary

1. Trading positions of Asia Exotic Index Trading desk

Risks located in this book are essentially a consequence of business made on autocalls sold in Korea for 4 billions Euro and for 700 millions Euro in Japan. Out of these 4,7 billions, Worst Of products represent 4,2 billions Euro.

2,5 billion should recall in less than 6 months even if spots drop by 10% and 1.5 billion more if spots stay at their current levels.

1.1. Autocalls sold in Korea: worst of several indices, quanto KRW

Size in MEUR	Recall @ spot*90%		Recall @ spot		Recall higher than spot		Grand Total
Maturity max in years	American D&I P	European D&I P	American D&I P	European D&I P	American D&I P	European D&I P	
1	0	0	8	7	18	46	79
2	47	12	10	9	1	3	81
3	1,368	969	357	877	126	3	3,699
4	8	0	24	2	0	0	34
5	32	55	0	28	0	0	115
Grand Total	1,454	1,036	398	923	145	52	4,008

Out of these ones, we can exhibit split of nominals by the underlying which is worst of the basket.

Size in MEUR Underlying	Recall @ spot*90%	Recall @ spot	Recall higher than spot	Grand Total
AS51	69	31	0	99
FXI UP	1	4	0	5
HSCEI	123	897	64	1,084
HSI	281	103	0	384
KOSPI2	247	3	126	376
NKY	440	31	7	478
SPX	285	0	0	286
SX5E	1,044	252	0	1,296
Grand Total	2,490	1,322	197	4,008

1.2. Autocalls sold in Japan: Worst of NKY/SP500, quanto JPY, only with american Down&In puts

Size in MEUR Maturity max in years	Recall @ spot*90%	Recall @ spot	Recall higher than spot	Grand Total
1	0	10	39	49
2	0	14	36	51
3	0	4	84	89
4	0	169	1	170
5	0	1	354	355
Grand Total	0	199	515	713

2. Risks review of Down&In put

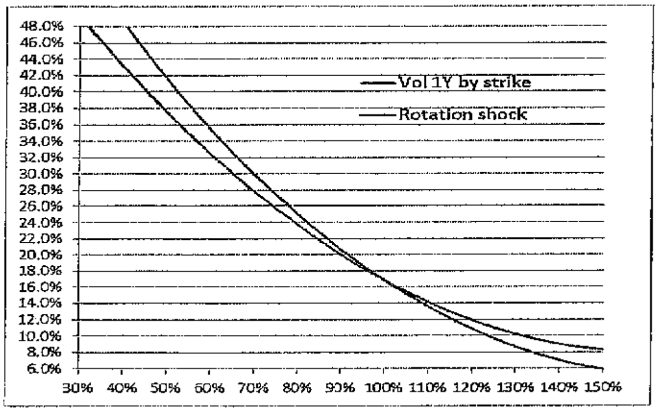
2.1. Representing volatility

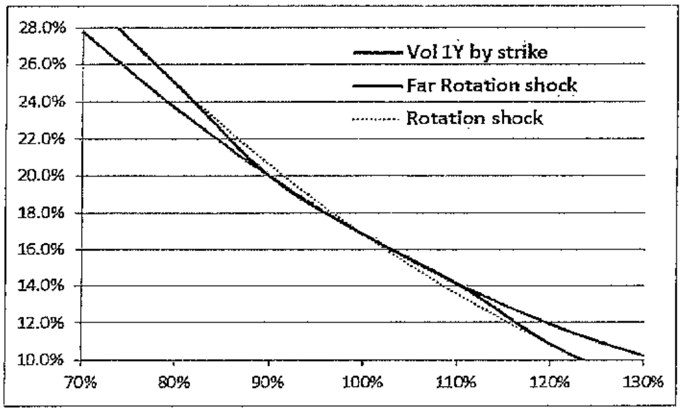
Using volatility as a unique implied term which fully describes the space/term structure of a log-normal distribution does not comply with market reality. This one differs from this convenient convention; reversing option prices quoted in IDB market reveals that distribution is not lognormal. Thus, an easy way to adapt the model is to associate to each strike an implied volatility: by term, it creates a shape of volatility, true bijection of the distribution.

Common description of this shape is made with volatility at the money, skew and convexity with a rough formula:

$$\sigma_{impli,T,K} = \sigma_{impli,T,K} + skew_T * \ln\left(\frac{K}{S}\right) + convex_T * \ln\left(\frac{K}{S}\right)^2$$

Therefore, we deduce a convenient way to express sensitivities of volatility surface deformations





Rotation sensi = Near Rotation sensi + Far Rotation sensi   wich is splittable between Downside and Upside

2.2. Description of a long position on a plain 5Y D&I European Put quanto in a designed currency

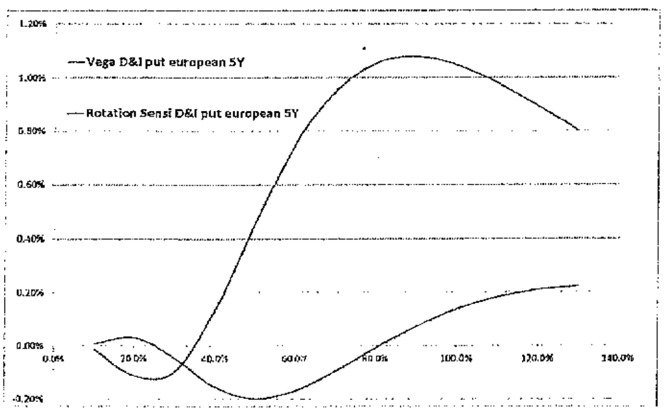
A European 5Y D&I Put is a regular vanilla position generating a long vega, long skew, short convexity on the 5Y

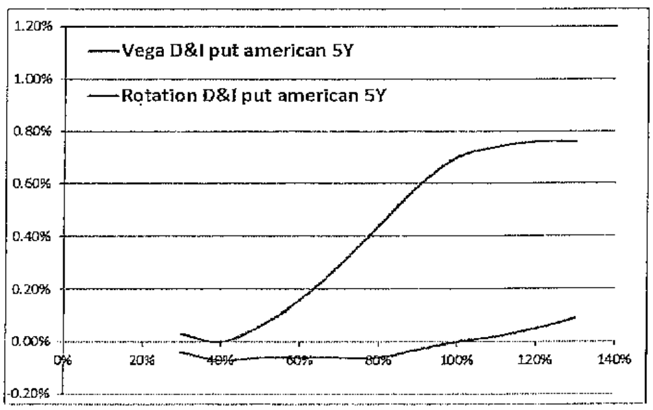
In addition, as any quanto product, it creates a cross derivate between equity and forex, inducing an exposure on carry P&L (realized covariance equity/forex) and sensitivities on correlation equity/forex and forex volatilities

2.3. Description of a long position on a plain D&I American Put quanto in a designed currency

A plain American 5Y D&I Put is already a model-dependent pay-off:

- It generates a long vega position concentrated on the 5Y term
- It has a small skew sensitivity which hides a long downside skew position due to downside digit netted by a short skew forward position due to conditional activation of the 100% put when spot is already at 60% (thus creating a short skew upside from a 60% spot point of view)
- it carries also a quanto exposure.





3. Risks review of an autocall: effects of the cancellation feature on Vannas

In a nutshell, an autocall position could be resumed in buying a 5Y, 100% Put Down&In @ 60% quanto in a designed currency, the whole put being deactivated if the worst underlying stands above a "recall barrier" at any anniversary date. Thus, it is a Down&In Put multiplied by a survival probability (which decreases if the spot moves up).

Let's write it as a buy of a product called P:

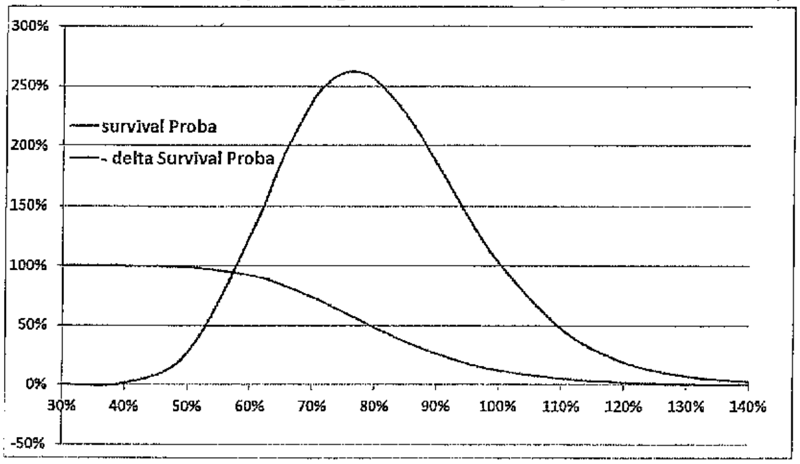
$$P(Spot, K_{put}, Barrier_{down\&in}, Recall_{level}, T) = Put_{Down\&In}(S, K, Barrier, T).Proba_{survival}(S)$$

3.1. Survival Probability shape

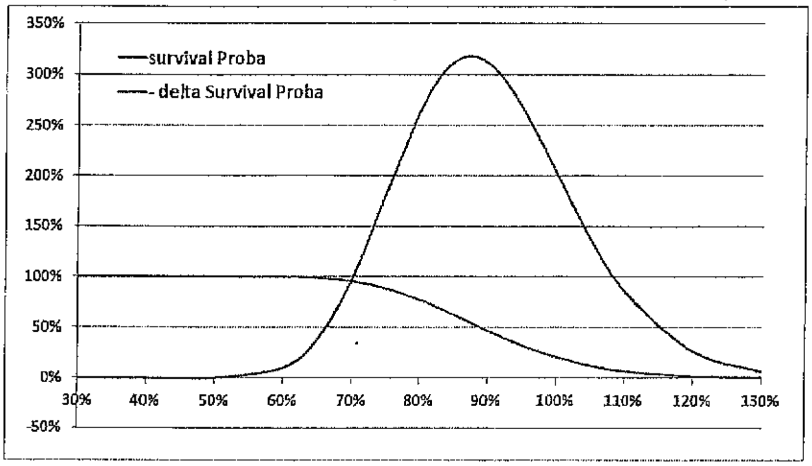
Obviously, the cancellation feature creates greeks due to its digital nature but the main risk is not there. As written above, the cancellation acts as a survival probability which decreases as the spot rises. As such, all greeks of D&I puts are multiplied by this probability rate and spot moves accelerate dynamics of the plain product.

Moreover, the redemption date depends on spot value, which creates a short covariance equity/rate; the same behavior applies to equity/funding covariance when the product is sold through an EMTN wrapper.

Survival Probability of Stepdown Recall every 6 months over 5 years, in function of Worst-of performance



Survival Probability of Recall @100 every 6 months over 5 years, in function of a single index performance



3.2. A digression about P&L (see *Annex I*)

These greeks are called "Vanna"

$$\text{"EqtyVol\_Vanna/voma"} = \begin{cases} \dfrac{\partial^2 P}{\partial S_i \partial \sigma_{j,atm}} \\ \dfrac{\partial^2 P}{\partial S_i \partial skew_j} \\ \dfrac{\partial^2 P}{\partial S_i \partial convex_j} \end{cases} \quad HybridVols\_Vanna = \begin{cases} \dfrac{\partial^2 P}{\partial S_i \partial \sigma_{rate,j}} \\ \dfrac{\partial^2 P}{\partial S_i \partial \sigma_{forex,j}} \\ \dfrac{\partial^2 P}{\partial S_i \partial \sigma_{div,j}} \end{cases} \quad \text{"Correl\_Vanna"} = \begin{cases} \dfrac{\partial^2 P}{\partial S_i \partial \rho_{eqty_j/eqty_k}} \\ \dfrac{\partial^2 P}{\partial S_i \partial \rho_{S_i/div_i}} \\ \dfrac{\partial^2 P}{\partial S_i \partial \rho_{S_j/rate_k}} \\ \dfrac{\partial^2 P}{\partial S_i \partial \rho_{S_j/forex_k}} \end{cases}$$

Let's call α_k all vols and correls (hybrid or not): EqtyVol (vol atm, skew, convex), Hybrid vols and Correls of all sorts.

P&L development comes with 3 main terms:

$$\text{"Eqty\_Gamma"\_}P\&L_{t\to t+1} = \frac{1}{2} \sum_{stock_i, stock_j} \frac{\partial^2 P}{\partial S_i \partial S_j} S_i S_j \left[ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right) ln\left(\frac{S_{j,t+1}}{S_{j,t}}\right) - Correl_{i,j} \frac{\sigma_{i,atm}\sigma_{j,atm}}{250} \right]$$

$$\begin{aligned} &\text{"Hybrid\_CrossGamma"\_}P\&L_{t\to t+1} \\ &= \sum_{stock_i, rate_j} \frac{\partial^2 P}{\partial S_i R_j} S_i R_j \left[ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right) ln\left(\frac{R_{j,t+1}}{R_{j,t}}\right) - Correl_{S,rate} \frac{\sigma_{S,atm}\sigma_{R,atm}}{250} \right] \\ &+ \sum_{stock_i, forex_j} \frac{\partial^2 P}{\partial S_i forex_j} S_i forex_j \left[ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right) ln\left(\frac{Fx_{j,t+1}}{Fx_{j,t}}\right) - Correl_{S,forex} \frac{\sigma_{S,atm}\sigma_{Fx,atm}}{250} \right] \\ &+ \sum_{stock_i, div_i} \frac{\partial^2 P}{\partial S_i div_i} S_i div_j \left[ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right) ln\left(\frac{div_{i,t+1}}{div_{i,t}}\right) - div\_yield\_proportion \frac{\sigma_{S,atm}\sigma_{S,atm}}{250} \right] \end{aligned}$$

$$\text{"All\_Vanna"\_}P\&L_{t\to t+1} = \sum_{stock_i, \alpha_k} \frac{\partial^2 P}{\partial S_i \partial \alpha_k} S_i \left[(\alpha_{k,t+1} - \alpha_{k,t}).\, ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right) - E[d\alpha_k . dln(S_i)] \right]$$

Which can be written in a shorter way:

$$\boxed{\text{"All\_Vanna"\_}P\&L_{t\to t+1} = \sum_{stock_i, \alpha_k} \frac{\partial^2 P}{\partial S_i \partial \alpha_k} S_i [RealisedCovar(S_i, \alpha_k) - ModelCovar(\ln(S_i), \alpha_k)]}$$

The two first terms (*Eqty Gamma* and *Hybrid CrossGamma*) are regular ones for which models correctly emulate covariances between spots and hybrid assets through Brownian motions or analytic dependencies.

The last term, so called Vanna, is the one which embodies a real risk when it comes to autocalls. Of course, this term is still valid to explain P&L on a non-path dependent pay off but both price and greeks are valid with local vol providing that the pay-off is homogenous to vanilla options.

Real differences in price and replication appear when pay-off differs from vanilla and exhibits strong Vanna effects, i.e. large values for $\frac{\partial^2 P}{\partial S \partial Vol_{eqty}}, \frac{\partial^2 P}{\partial S \partial Vol_{hyb}}, \frac{\partial^2 P}{\partial S \partial Correl}$ combined with a spread between realised covariance and covariance generated by the model.

3.3. Quantifying Vannas intensity of autocalls due to survival probability

In other terms, all greeks exhibited are exposed to variation due to spot moves, which creates strong cross-derivatives Spot/Equity vol, Spot/Hybrid Vols, Spot/Correls.

Our Vannas are written as $\frac{\partial^2 P}{\partial S_i \partial \alpha_k}$

Knowing that $P\left(Spot, K_{put}, Barrier_{down\&in}, Recall_{level}, T\right) = Put_{Down\&In}(S, K, Barrier, T).Proba_{survival}(S)$

$$\frac{\partial^2 P}{\partial S \partial \alpha_k} = \frac{\partial^2 [Put_{Down\&In}(S, K, Barrier, T).Proba_{survival}(S)]}{\partial S \partial \alpha_k}$$
$$= \frac{\partial Put}{\partial S}\frac{\partial Proba}{\partial \alpha_k} + \frac{\partial Proba}{\partial S}\frac{\partial Put}{\partial \alpha_k} + \frac{\partial^2 Proba}{\partial S \partial \alpha_k}.Put + \frac{\partial^2 Put}{\partial S \partial \alpha_k}.Proba$$

When *Proba*>90% or *Proba*<10% the product behaves either like a regular D&I Put either, sensitivities are minored, due to survival rate. Product embodies a Vanna risk not homogenous to a regular D&I Put when *Proba* is in [10%,90%].

Plain D&I Put has a downside activation, therefore, absolute values of risks are lower when S is up i.e. $\frac{\partial \left|\frac{\partial Put}{\partial \alpha_k}\right|}{\partial S} < 0$

$\frac{\partial Proba}{\partial S} < -1$, then $\frac{\partial Proba}{\partial S}\left|\frac{\partial Put}{\partial \alpha_k}\right|$ is negative with a high intensity because it is multiplying the initial greek by a quantity greater than one.

One can assume that $\frac{\partial Put}{\partial S}\frac{\partial Proba}{\partial \alpha_k}$ and $\frac{\partial^2 Proba}{\partial S \partial \alpha_k}$ have a low intensity given the low dependency of *Proba* to α_k

Then in the range of *Proba* [10%,90%] where $\frac{\partial Proba}{\partial S} < -1$, $\frac{\partial \left|\frac{\partial P}{\partial \alpha_k}\right|}{\partial S} \approx \frac{\partial Proba}{\partial S}\left|\frac{\partial Put}{\partial \alpha_k}\right| + \frac{\partial \left|\frac{\partial Put}{\partial \alpha_k}\right|}{\partial S}.Proba \ll \frac{\partial \left|\frac{\partial Put}{\partial \alpha_k}\right|}{\partial S} < 0$

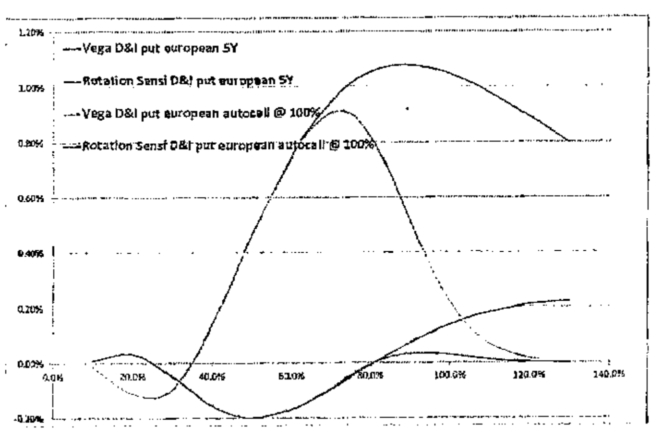
Thus, Vanna intensity of a D&I Put cancellable is maximum when $\left|\frac{\partial Proba}{\partial S}\right|$ is at its highest, i.e. when *Proba* = 50%

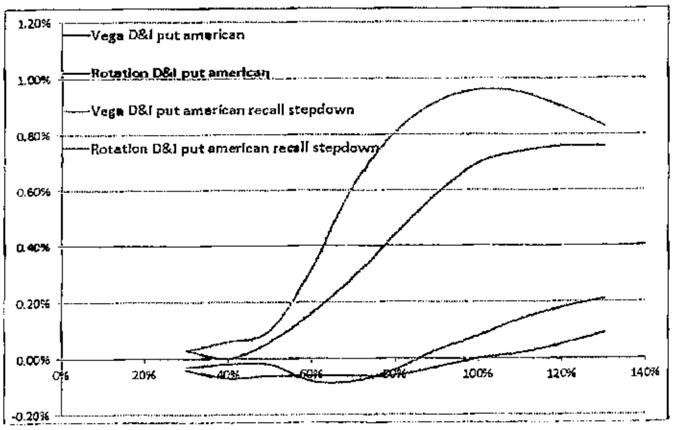
$$\frac{\partial^2 Autocall}{\partial S \partial \alpha_k} \approx \frac{\partial Proba_{survival}}{\partial S}\frac{\partial Put_{down\&in}}{\partial \alpha_k} + Proba_{survival}.\frac{\partial^2 Put_{down\&in}}{\partial S \partial \alpha_k}$$

One verifies here that the highest versatility of greeks is maximum around a survival probability of 50%.
It shows also that the Vanna of a D&I Put cancellable is much higher than the Vanna of a regular D&I Put.

Indeed, while looking at the vega/rotation sensitivity moves due to spot (vega move due to spot is homogenous to EqtyVol Vanna), one remarks that greeks acceleration is far greater with a callability feature.

Here, we compare 5Y D&I put against the same put but cancellable when spot is above recall level.





4. Pricing and hedging add-ons due to Vannas of the Asia Exotic Index book

4.1. Defining add-on valuation

The extra valuation due to the rehedging induced by Vanna is:

$$"All\_Vanna"\_P\&L_{0\to T} = \int_0^T \sum_{stock_i,\alpha_k} \frac{\partial^2 P}{\partial S_i \partial \alpha_k} S_i[RealisedCovar(\ln(S_i),\alpha_k) - ModelCovar(\ln(S_i),\alpha_k)]$$

Autocall specificities of pricing and hedging appear in this only term. All other effects are correctly priced through a local volatility model. Which means that painful carry P&L should be hedged trough an instrument providing an approximate pay-off of this term.

Vanna is maximum (see *section 3.3.* above) when spots are evolving in a range of [-20%;+20%] around 90% of recall barrier. The *daily P&L* of Vannas in this range is homogenous to:

$$\frac{\int_0^T \sum_{stock_i,\alpha_k} \frac{\partial^2 P}{\partial S_i \partial \alpha_k} S_i[RealisedCovar(\ln(S_i),\alpha_k) - ModelCovar(\ln(S_i),\alpha_k)]}{252.T}$$

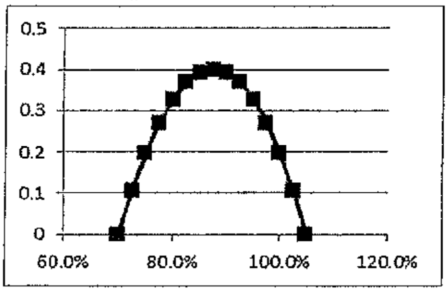
4.2. Designing an over-coupon, a "cheap model" to address All Vannas misevaluation

The goal is to buy a pay-off which provides extra P&L to compensate the miscarry of multiple realised covariances which occur in ranges where Vanna is the greatest, i.e. in a range of [-20%;+20%] around 90% of recall barrier.

As said above, it will create profit when the difference $[RealisedCovar(\ln(S_i),\alpha_k) - ModelCovar(\ln(S_i),\alpha_k)]$ really matters, i.e. when Vanna is maximal.

Hedging pay-off

- every day during 3 years, if the Worst of spot is in the range of [70%;105%] of initial spot
    - over-coupon pays a flat coupon of 0.40%.
    - more precisely, this flat coupon should get a parabolic shape where its value is maximum at 87.5% and will be null if spot reaches 70% of the barrier on the left side and 105% on the other side.



- if, at any recall date (every semester), the worst of is above 85%, the over-coupon dies as the whole pay-off does.

Hence, if during 3 years, every day the spot stands at 87.5%, one will get 0.40% * 250 * 3 = 300% of the notional.

Pricing of this pay-off is around 30% upfront.

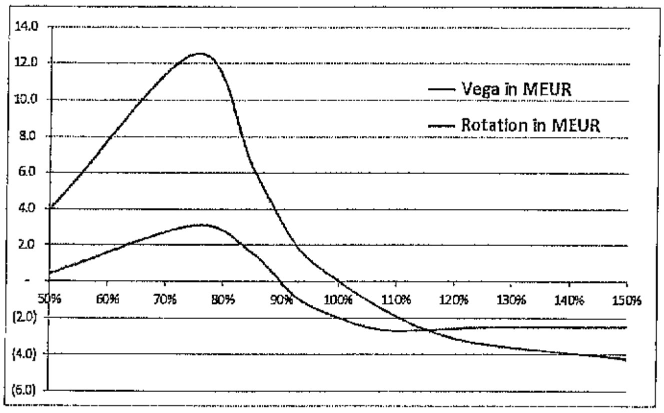
If we want to provide an extra 100keuro P&L needed by any Vanna miscarry, we shall invest 9mEUR in this over-coupon.

Overall, this over-coupon acts as a "cheap model", meaning that it compensates the "no-diffusion" or the wrong diffusion of EqtyVol, HybridVols and Correls. By saying "no-diffusion", it means also the absence of combined diffusion with spot.

Nota bene: regarding spot/vol diffusion, local vol model creates it but with an improper covariance (*cf. Annex 2*)

4.3. Eqty Vol Vanna/Voma term

Asia Exotic Index Trading desk carries several Vanna exposures as described above. Vega and rotation evolutions regarding the spot level give a proper value to this Vanna position. To understand how we compute the adverse carry loss when spots are reaching the zone of high Vanna (around 80% of current spot), the reader can consult *Annex 2*.



For a +1% spot move around 80%

	Creation of vega in Meur	Creation of rotation in Meur	Adverse carry daily in keur
HIS	-0.17	-0.04	30
HSCEI	-0.02	0.00	0
SX5E	-0.19	-0.02	30
SPX	0.00	-0.01	0
NKY	-0.02	0.02	0
KOSPI2	-0.22	-0.11	60
TOTAL	-0.62	-0.15	120

Realised covariances between spot and rotation are negative, since the covariance generated by local vol model is close to zero, the current shape of Vanna spot/rotation is favorable to our valuation, therefore, we do not compute gain induced.

We recommend to invest into an over-coupon for Eqty Vol Vanna term, in order to hedge these standard miscarries due to combined spot/vol variations. It should be homogenous to valuation add-on provided by the calculation of autocalls with a Stochastic vol model.

4.4. Hybrid Vols Vanna term

4.4.1. Forex vol vanna

Spot ladder	KRW forex vega in kEUR	Vanna Vol forex for +1% spot move
50.0%	-3,000	-28
75.0%	-3,700	190
85.0%	-1,800	187
92.5%	-400	107
100.0%	400	53
107.5%	800	27
115.0%	1,000	9

One could address the cost of an adverse covariance through 2 methods:

- Either a macro hedge or over-coupon like the one we want to build on Eqty Vol vanna/voma
- Either through a conservative over-marking of forex volatility which synthetize a skewed volatility marking

The method of over-marking presents strong advantages:

- It anticipates the risk of forex volatility rising when spot moves down, thus there is no painful daily remarking
- It creates a long delta which has to be hedged (which is also an anticipation)

4.4.2. Rate Vol vanna and Div Vol vanna

We can recommend to adopt the same strategy: conservative over-marking of rate vol and dividend beta (expressed in the weighting between cash div and proportional div).

4.5. Correls Vanna term

4.5.1. Correl quanto vanna

$$\frac{\partial P}{\partial \rho_{qto}} = \frac{\partial P}{\partial Fwd_{qto}} \frac{\partial Fwd_{qto}}{\partial \rho_{qto}} = \frac{\partial P}{\partial Fwd_{qto}} Fwd_{qto}.\sigma_{forex}\sigma_{eqty}.T$$

Besides, $\frac{\partial P}{\partial \sigma_{forex}} = \frac{\partial P}{\partial Fwd_{qto}} \frac{\partial Fwd_{qto}}{\partial \sigma_{forex}} = \frac{\partial P}{\partial Fwd_{qto}} Fwd_{qto}.\rho_{qto}\sigma_{eqty}.T$

Therefore, $\boxed{\frac{\partial P}{\partial \rho_{qto}} = \frac{\partial P}{\partial \sigma_{forex}}.\frac{\sigma_{forex}}{\rho_{qto}}}$

Hence, we deduce from the ForexVol Vanna, the Correl quanto Vanna (correl qto ~65% and vol forex ~15%)

	without forex vanillas		
Spot ladder	KRW forex vega in kEUR	Vanna Vol forex for +1% spot move	Correl qto sensi / 1 correl point
50.0%	-3,350	-28	-722
75.0%	-4,050	190	-872
85.0%	-2,150	187	-463
92.5%	-750	107	-162
100.0%	50	53	11
107.5%	450	27	97
115.0%	650	6	140

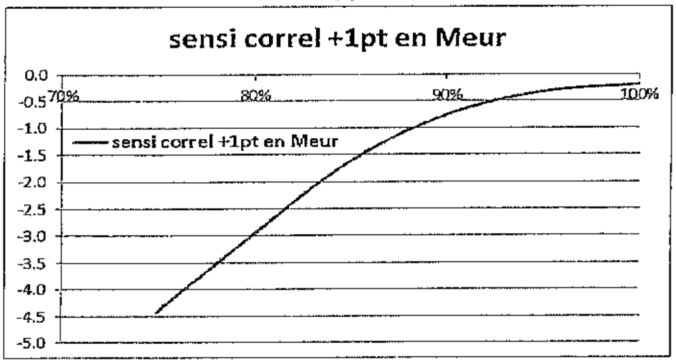
Conservative over-marking of these correls quanto addresses smartly their rising when spot moves down.

4.5.2. Correl eqty/eqty Vanna

The Vanna correl has been quite hard to obtain: it is a mix between a rough approximation and a full repricing done by DRM with a spot move at -25%. It gives the Cega deformation as below.

Approximation is made with: delta of worst-of product, worst of forward dependency to correlation, duration (known as θ)

$$\frac{\partial P}{\partial \rho_{eqty}} = \frac{\partial P}{\partial Fwd_{WO}}.\frac{1}{\sqrt{2\pi}}\sigma_{eqty}\frac{\left[\sqrt{2(1-(\rho+\Delta\rho))\theta} - \sqrt{2(1-\rho)\theta}\right]}{\Delta\rho}$$



This sensitivity is rather important and could be managed through a mix of several strategies:

- consequent gap marking of digits and opportunistic profit taking when market drops
- Over-marking of correlation
- Buying downside convexity against systemic crisis which will concur with a strong rise of correlation

Implied covariance between spot and implied correlation is null in our models (⇔ no "correl local" model).

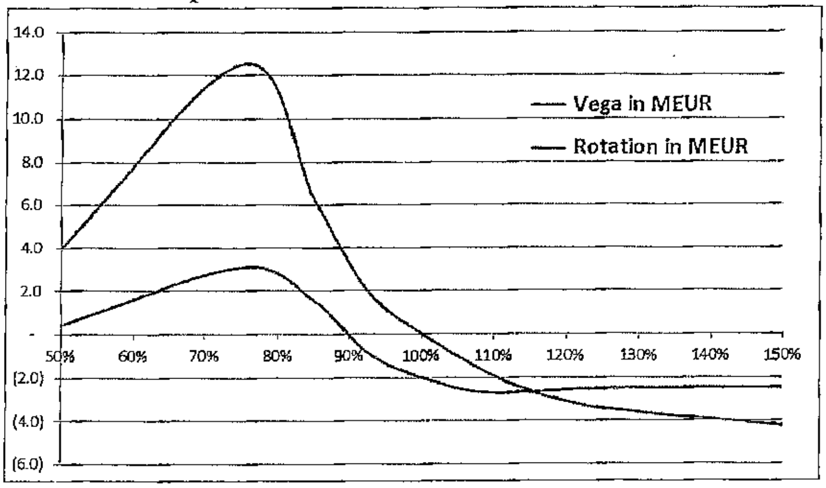
The realized covariance between spot and implied correlation is hard to compute because of the strong inertia of implied correlation. Usually, realised covariance is small for a quite wide range of spot but, a quick and important remarking can occur when the market goes quickly in the 85% zone.

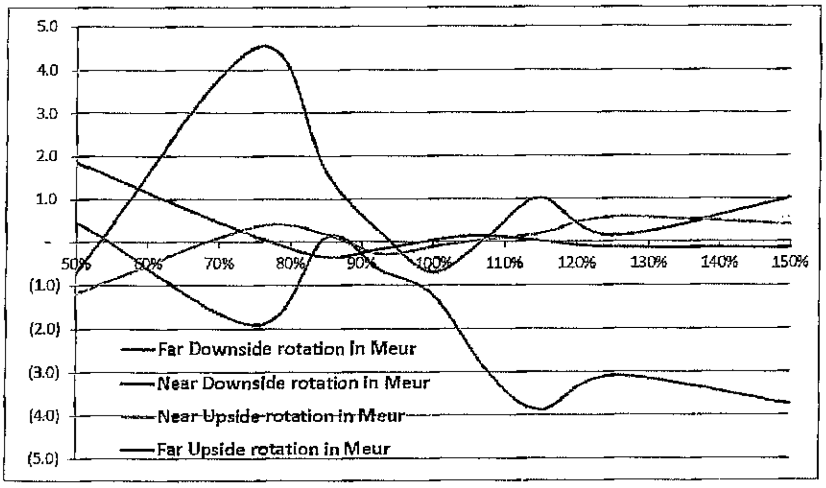
That is why, correlation increase should better be seen as a crisis scenario, manageable through a macro hedge (convexity buying) or an over-marking of correlation.

5. Macro-hedge possibilities for systemic crisis

Aside of hedging Vannas miscarries, one should take also a look to tail risks in case of a massive drop of the market or a real quick reevaluation of convexity parameters. Such event occurred in autumn 2015, on HSCEI and SX5E.

5.1. Current exposure of the book





5.2. Hedging proposals

Objectives are to reduce Rotation exposure which stays negative in a wide range and Vega deformation when spot moves in a close range. By achieving this, it will protect book against strong remarking of convexity at current and lower spots and it will improve the EquityVol Vanna carry in the 90%/110% spot range. We calculated the cost of carry of these hedges. Roughly, it confirms the common sense that the good hedge is to sell downside put spreads ratio for a consequent size.

It sounds as a complement to the over-coupon which handles All Vannas miscarries in the 70%/105% zone.

In *Annex 3*, you will find all details regarding hedge proposals split by underlying: vega by strike/maturity, Varswaps, profile of greeks and cost of carry. Of course, given the sizes, it will take time to put that in place.

5.3. Sum up of hedging proposals

Position post hedge in Meur

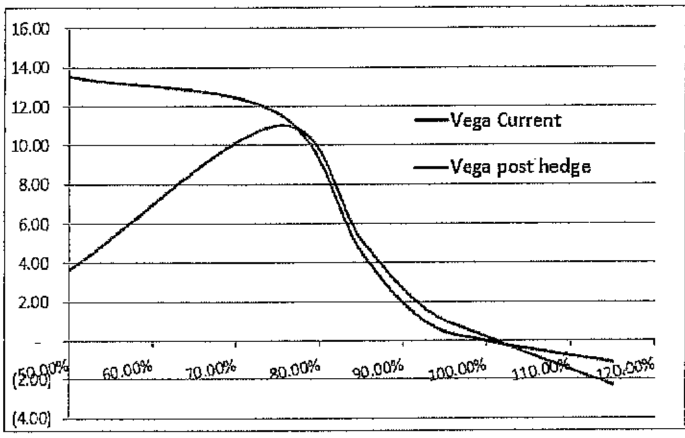
scenar	Vega	Rotation	Far Downside rotation	Near Downside rotation	Near Upside rotation	Far Upside rotation
115.00%	-1.1	-1.9	-3.1	1.1	0.0	0.0
100.00%	0.0	-0.7	2.1	-2.4	-0.5	0.0
92.50%	1.0	0.9	2.8	-1.1	-0.7	-0.2
85.00%	4.5	3.7	3.8	0.7	-0.4	-0.4
75.00%	11.6	6.7	3.4	3.4	0.0	-0.1
50.00%	13.5	7.4	5.6	0.9	-0.5	1.5

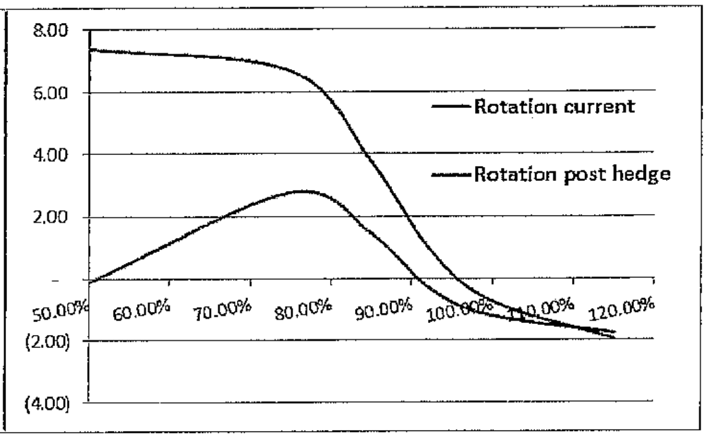
Current Position in Meur

Spot	Vega	Rotation	Far Downside rotation	Near Downside rotation	Near Upside rotation	Far Upside rotation
115%	-2.3	-1.8	-2.8	0.9	0.2	0.0
100%	0.2	-1.2	-0.5	-0.6	-0.1	0.0
93%	1.7	-0.4	-0.3	0.3	-0.2	-0.2
85%	5.2	1.4	0.2	1.4	0.2	-0.3
75%	11.0	2.8	-1.5	3.9	0.2	0.1
50%	3.7	-0.1	0.4	-0.8	-1.3	1.5

CARRY due to hedge range 90%/110%

P&L vanna	4.9
Gamma Carry	(7.0)
TOTAL	(2.1)





A hedge of this type presents strong advantages

- it reduces rotation sensitivity by 40% (from -1.2meur to -0.7meur) at current spot
- when spot moves down, it creates quickly a long downside rotation sensitivity
- in case of huge drop of the market (-50%), it generates a long vega in a distressed situation
- it divides Vanna by almost 2 around current spot, which avoids a real painful Vanna rehedging
- It is feasible at an approximated yearly loss of 2meur

Drawbacks

- Sizes to trade are important and feasible over a period of 4 months
- Providing that the market is squeezed in this way, entry points could be less attractive than current ones
- At current spot, it creates a long downside convexity versus short downside skew risk

This risk is mitigated by following facts

- risk is carried by NKY/SX5E/SPX/ which are major indices with vol liquidity scaling from standard to excellent
- It could be rehedged easily and quickly on SPX
- Short skew position reacts slowly to crisis in comparison with convexity which moves up sharply

Annex 1 Replication of an exotic pay-off

1. Market data involved in pricing/replication of any product

- 1st order market data are tradable assets diffused through different schemes (model or analytical dependencies)
- 2nd order market data are volatilities (in a general acception), not diffused and marked in a dynamic or a static way, designated here as $Vol_{eqty,k}$ and $Vol_{hyb,k}$
- 3rd order data are correlations, not diffused and marked in a dynamic or a static way, designated here as $Correl_k$

1st order market data diffusion	Eqty spot through local volatility model	Eqty dividend trough analytical link with spot	rates through HJM model	forex through forward quanto adjustment
2nd order data no diffusion	atm vol, skew, convexity remarked @ mark-to-market	dividend vol static marking through proportional div yield	rate vol conservative static marking	forex vol conservative static marking
2nd order "crossed" data no diffusion	Correl eqty/eqty conservative dynamic marking	Correl spot/div static marking through proportional div yield	Correl spot/rate conservative static marking	correl spot forex Conservative static marking

2. Taylor development

For a product P, we will look at second orders terms, assuming that all first orders derivates are hedged daily: i.e. delta, vega, rate sensi, div sensi, forex sensi, skew sensi, convexity sensi.

$$"Eqty\_Gamma"\_P\&L_{t\to t+1} = \frac{1}{2}\sum_{stock_i,stock_j}\frac{\partial^2 P}{\partial S_i S_j}S_iS_j\left[ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right)ln\left(\frac{S_{j,t+1}}{S_{j,t}}\right) - Correl_{i,j}\frac{\sigma_{i,atm}\sigma_{j,atm}}{250}\right]$$

$$"Hybrid\_CrossGamma"\_P\&L_{t\to t+1}$$
$$= \sum_{stock_i,rate_j}\frac{\partial^2 P}{\partial S_i R_j}S_iR_j\left[ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right)ln\left(\frac{R_{j,t+1}}{R_{j,t}}\right) - Correl_{S,rate}\frac{\sigma_{S,atm}\sigma_{R,atm}}{250}\right]$$
$$+ \sum_{stock_i,forex_j}\frac{\partial^2 P}{\partial S_i Fx_j}S_iFx_j\left[ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right)ln\left(\frac{Fx_{j,t+1}}{Fx_{j,t}}\right) - Correl_{S,Fx}\frac{\sigma_{S,atm}\sigma_{Fx,atm}}{250}\right]$$
$$+ \sum_{stock_i,div_i}\frac{\partial^2 P}{\partial S_i div_i}S_idiv_j\left[ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right)ln\left(\frac{div_{i,t+1}}{div_{i,t}}\right) - div\_yield\_proportion\frac{\sigma_{S,atm}\sigma_{S,atm}}{250}\right]$$

$$"EqtyVol\_Vanna/voma"\_P\&L_{t\to t+1}$$
$$= \sum_{stock_i,\sigma_j}\frac{\partial^2 P}{\partial S_i\partial\sigma_{j,atm}}S_i\left[(\sigma_{j,atm,t+1} - \sigma_{j,atm,t}).\,ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right) - E\left[d\sigma_{j,atm}.\,dln(S_i)\right]\right]$$
$$+ \sum_{stock_i,skew_j}\frac{\partial^2 P}{\partial S_i\partial skew_j}S\left[(skew_{j,t+1} - skew_{j,t}).\,ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right) - E\left[dskew_j.\,dln(S_i)\right]\right]$$
$$+ \sum_{stock_i,convex_j}\frac{\partial^2 P}{\partial S_i\partial convex_j}S\left[(convex_{j,t+1} - convex_{j,t}).\,ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right) - E\left[dconvex_j.\,dln(S_i)\right]\right]$$
$$+\frac{1}{2}\sum_{\sigma_i,\sigma_j}\frac{\partial^2 P}{\partial\sigma_i\partial\sigma_j}S\left[(\sigma_{i,t+1} - \sigma_{i,t}).\,(\sigma_{j,t+1} - \sigma_{j,t}) - E\left[d\sigma_i d\sigma_j\right]\right]$$

$$"HybridVols\_Vanna"\_P\&L_{t\to t+1}$$
$$= \sum_{stock_i,\sigma_{rate,j}}\frac{\partial^2 P}{\partial S_i\partial\sigma_{rate,j}}S_i\left[(\sigma_{rate,j,t+1} - \sigma_{rate,j,t}).\,ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right) - E\left[d\sigma_{rate,j}.\,dln(S_i)\right]\right]$$
$$+ \sum_{stock_i,\sigma_{forex,j}}\frac{\partial^2 P}{\partial S_i\partial\sigma_{fx,j}}S_i\left[(\sigma_{fx,j,t+1} - \sigma_{fx,j,t}).\,ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right) - E\left[d\sigma_{fx,j}.\,dln(S_i)\right]\right]$$
$$+ \sum_{stock_i,\sigma_{div,j}}\frac{\partial^2 P}{\partial S_i\partial\sigma_{div,j}}S_i\left[(\sigma_{div,j,t+1} - \sigma_{div,j,t}).\,ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right) - E\left[d\sigma_{div,j}.\,dln(S_i)\right]\right]$$

$$"Correl\_Vanna"\_P\&L_{t \to t+1}$$
$$= \sum_{stock_i, Correl_{eqty_j/eqty_k}} \frac{\partial^2 P}{\partial S_i \partial \rho} S_i \left[\left(\rho_{S_j/S_k,t+1} - \rho_{S_j/S_k,t} \right) . ln\left(\frac{S_{i,t+1}}{S_{i,t}} \right) - E\left[d\rho_{S_j/S_k} . dln(S_i) \right] \right]$$
$$+ \sum_{stock_i, Correl_{S_i/div_i}} \frac{\partial^2 P}{\partial S_i \partial \rho} S_i \left[\left(\rho_{S_i/div_i,t+1} - \rho_{S_i/div_i,t} \right) . ln\left(\frac{S_{i,t+1}}{S_{i,t}} \right) - E\left[d\rho_{S_i/div_i} . dln(S_i) \right] \right]$$
$$+ \sum_{stock_i, Correl_{S_j/rate_k}} \frac{\partial^2 P}{\partial S_i \partial \rho} S_i \left[\left(\rho_{S_j/rate_k,t+1} - \rho_{S_j/rate_k,t} \right) . ln\left(\frac{S_{i,t+1}}{S_{i,t}} \right) - E\left[d\rho_{S_j/rate_k} . dln(S_i) \right] \right]$$
$$+ \sum_{stock_i, Correl_{S_j/fx_k}} \frac{\partial^2 P}{\partial S_i \partial \rho} S_i \left[\left(\rho_{S_j/fx_k,t+1} - \rho_{S_j/fx_k,t} \right) . ln\left(\frac{S_{i,t+1}}{S_{i,t}} \right) - E\left[d\rho_{S_j/fx_k} . dln(S_i) \right] \right]$$

Equity gamma P&L and **Hybrid CrossGamma P&L** are correctly addressed with current models

- models are correlating spot with rate, forex and dividend
  - volatility local with stochastic rate
  - analytical beta for dividends and quanto adjustment for forex
- local vol model deals with multi underlying cross diffusions

EqtyVol Vanna/voma P&L details the carry P&L induced by a crossed sensitivity between equity spot and equity vol (in an extensive meaning, i.e. vol, skew and convex):

- This generates P&L as soon as realised covariance spot/vol differs from "model generated covariance".

HybridVols Vanna P&L details the carry P&L induced by a crossed sensitivity between equity spot and "hybrid" assets volatility (rates, forex, div).

- This generates P&L as soon as realised covariance spot/other vols differs from "model generated covariance".

Correl Vanna P&L details the carry P&L induced by a crossed sensitivity between equity spot and every correlation.

- This generates P&L as soon as realised covariance spot/correl differs from "model covariance" (equal to zero)

3. Sum up

Current models deal correctly with crossed derivatives between 1st order market data

- spot, rate, forex and div behave as random assets (through different schemes)
- covariances between spot and the 3 others are emulated accordingly to implied or realized levels

Current models do not dedicate Brownian motions to diffuse 2nd order and 2nd order "crossed" market data.

- Vol_{eqty} has a behavior only emulated by local volatility dynamics, which means that covariance spot/vol and vol of vol are not calibrated against implied or realized levels but deducted from local volatility inner properties
- Vol_{hyb} are purely static
- $Correl_{spot/spot}$ and $Correl_{hyb/spot}$ are purely static

Of course, as soon as pay-offs are mainly strippable on vanilla options, these weaknesses are harmless, the pay off being model-independent. The 3 last terms of this Taylor expansion are still valid to explain P&L but both price and greeks are valid with local vol providing that the pay-off is homogenous to vanilla options.

Real differences in price and replication appear when pay-off differs from vanilla and exhibits strong vanna effects, i.e. large values for $\frac{\partial^2 P}{\partial S \partial Vol_{eqty}}, \frac{\partial^2 P}{\partial S \partial Vol_{hyb}}, \frac{\partial^2 P}{\partial S \partial Correl}$

Annex 2 EqtyVol Vanna/Voma and model choice/calibration

1. Skew Stickyness ratio

Let's introduce the Skew Stickyness Ratio (SSR) which is:

$$SSR_T = \frac{\frac{E[d\sigma_{atm}.dln(S)]}{E[dln(S)^2]}}{\frac{d\sigma_{impli,K,T}}{dk}} = \frac{\frac{E[d\sigma_{atm}.dln(S)]}{E[dln(S)^2]}}{skew_{impli,K,T}}$$

$\frac{E[d\sigma_{atm}.dln(S)]}{E[dln(S)^2]}$ represents the combined dependency spot/vol

- If we compute realized historical covariance spot/vol, and it is the historical realised skew
- If we look at the dynamics of the chosen model, it is the model-generated skew

Therefore, SSR could be employed as a ratio of realized skew versus implied skew or as a ratio of model-generated skew versus implied skew.

- When the value is 0, the historical data (or the model) show a sticky delta behavior of the vol.
- When the value is 1, the historical data (or the model) show a sticky strike behavior of the vol.
- When the value is 2, the historical data (or the model) show a sticky Dupire behavior of the vol.

The first cross term spot/vol $\frac{\partial^2 P}{\partial S \partial \sigma_{atm}} S \left[(\sigma_{atm,t+1} - \sigma_{atm,t}).ln\left(\frac{S_{t+1}}{S_t}\right) - E[d\sigma_{atm}.dln(S)] \right]$ can be reformulated as

$$\frac{\partial^2 P}{\partial S \partial \sigma_{atm}} S \left[ln^2\left(\frac{S_{t+1}}{S_t}\right).RealisedSSR_{t\to t+1} - \frac{\sigma^2_{atm}}{250}.ModelSSR_{t\to t+1} \right].skew_{impli,K,T}$$

2. Model choice for autocalls

Local volatility is a very powerful diffusive model with real conveniences, which ensures proper calibration of vanilla options. But the SSR generated by Local Vol is roughly stuck around 2, when range of realized SSR among main indices is between -2 and 1,5.

It could be harmless but autocalls are specifically exposed to this calibration, because of the intensity of $\frac{\partial^2 P}{\partial S \partial \sigma_{atm}}$ which is negative.

By pricing autocalls with Local Vol and its SSR at 2, one overestimates the realization of skew, which gives a lower price for this product.

Nota bene:

A stochastic volatility model, with a vol of vol and a covariance spot/vol calibrated both on historical realisations (long term), will generate a lower SSR and create a theta which balances the real carry of this EqtyVol Vanna.

This allows a proper valuation of the book. The spread between LocalVol and StochVol valuation is maximum for a spot equal to 90% of the recall barrier; it converges to zero far above or far below.

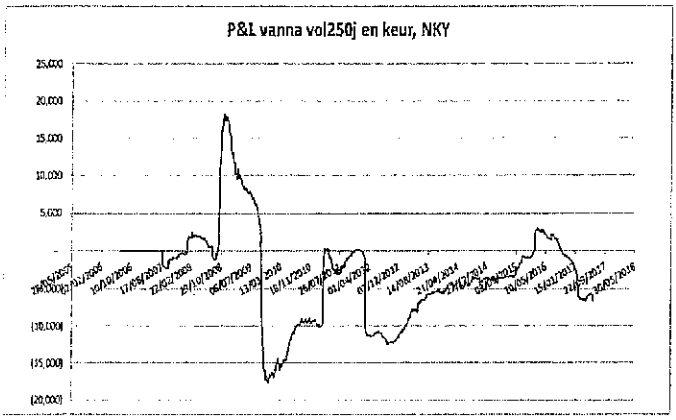
Because of this shape, greeks spread (especially delta) between the 2 models need to be hedged. The over-coupon approach tends to fulfill this task. Of course it is an imperfect substitute, that is why we can call it a "cheap model".

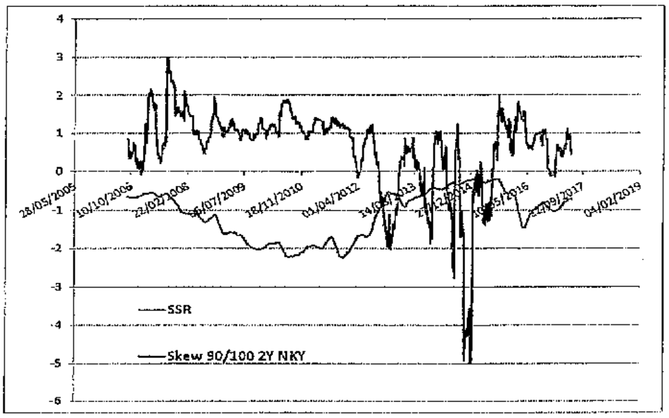
3. Historical realisations of SSR

The loss of P&L induced by a local volatility pricing and hedging could be important. The well-known case of volatility NKY in 2012 exhibits consequent losses due to this mispricing and mishedging.

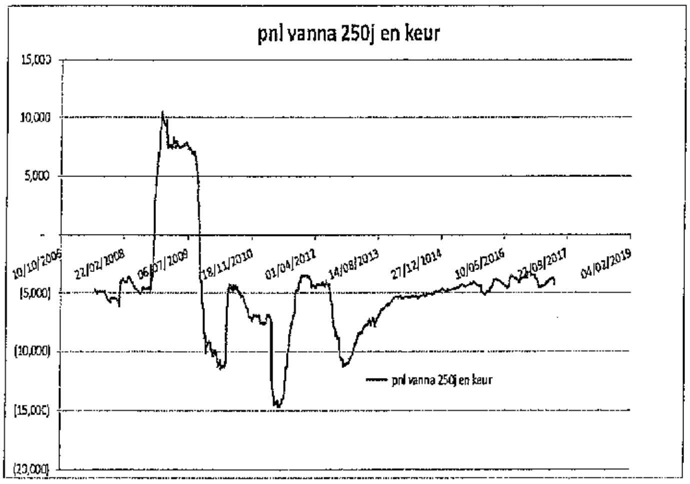
P&Ls shown here are computed with a vanna position of -100kEuro vega for +1% spot move. Of course, with low skew, the formula using SSR is less accurate, that is why I computed the real P&L due to vanna vol. P&L is represented for a 1 year carry.

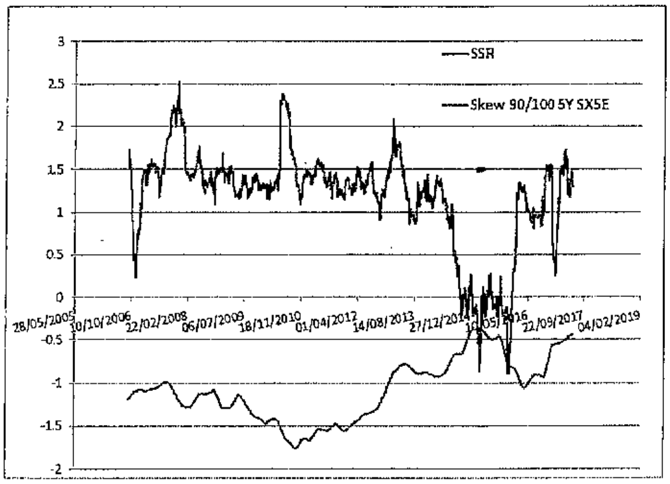
NKY





SX5E





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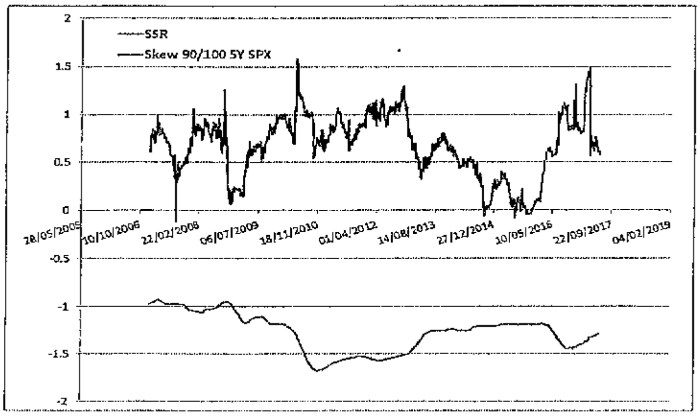

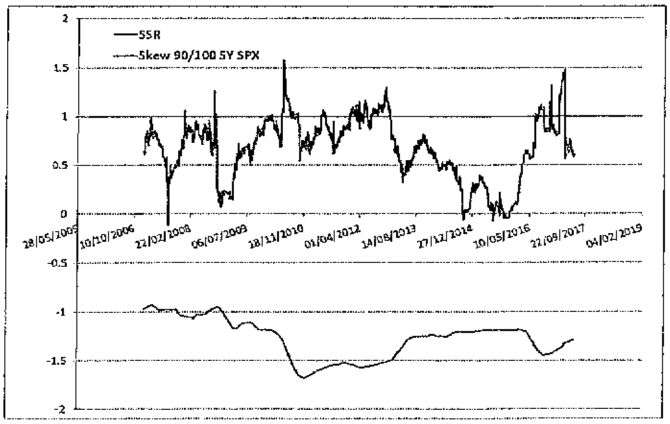

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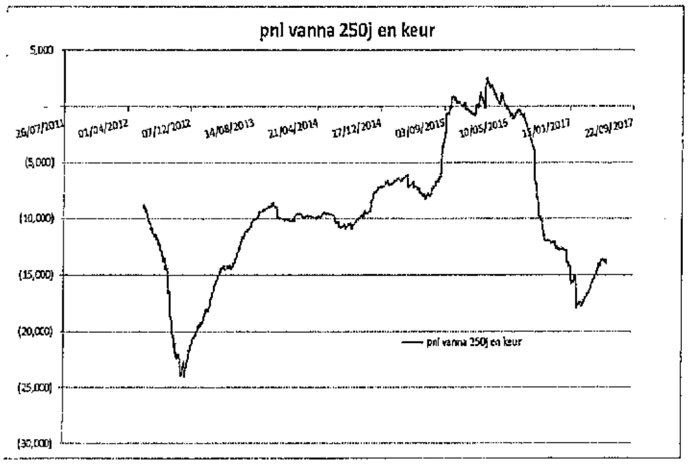
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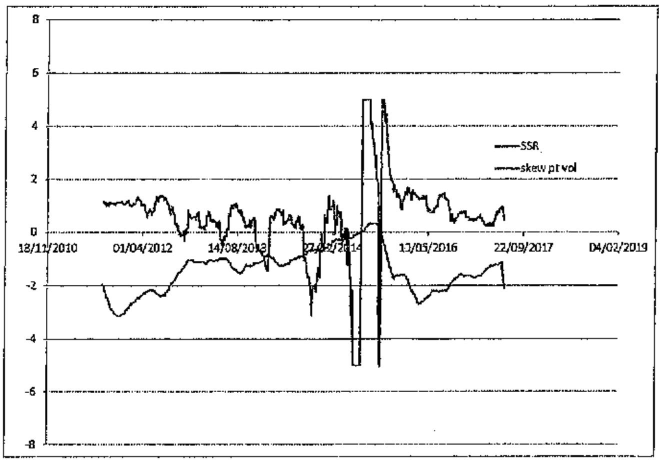
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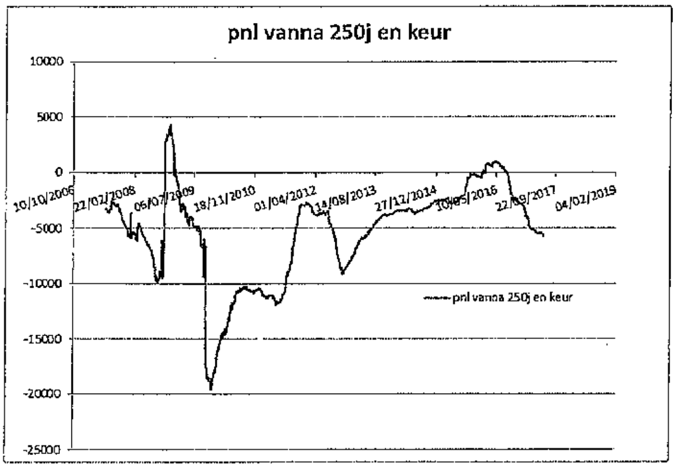
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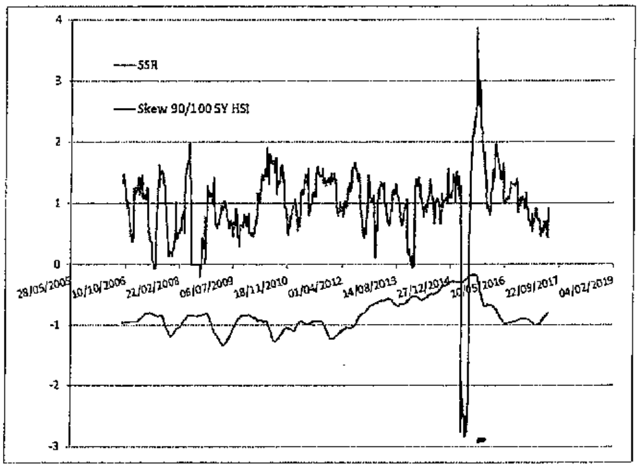
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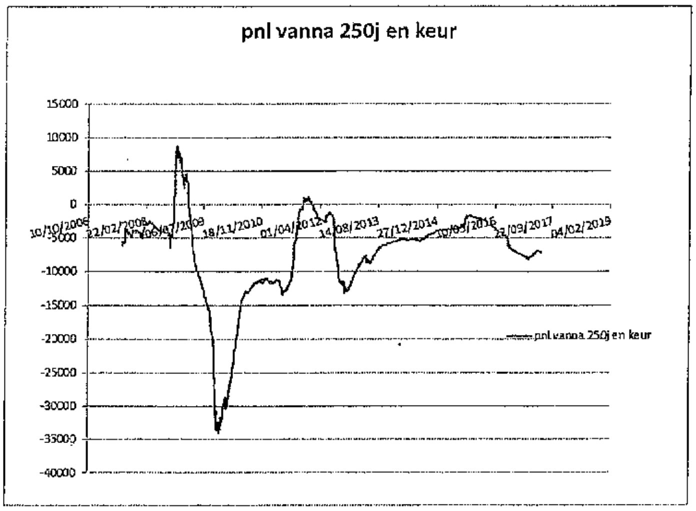
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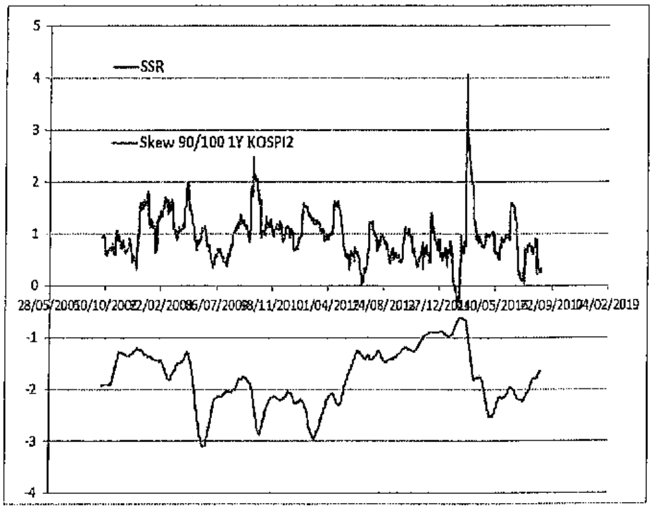
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04/02/2019

Annex 3 Hedge proposal for convexity risk and local vanna miscarry

1. SPX

Hedge proposal

VarSwaps in Meur	SPX	Vega Vanilla in Meur 30.0%	45.0%	60.0%	80.0%	85.0%	100.0%	120.0%	TOTAL by T
-	16/09/2017	-	-	-	-	-	-	-	-
-	16/12/2017	-	-	-	-	-	-	-	-
-	16/06/2018	-	-	0.2	-	(0.4)	0.6	-	0.4
1.0	16/06/2019	-	-	-	(1.0)	(0.3)	0.4	0.1	0.2
-	16/06/2020	-	0.4	-	(1.2)	(1.2)	2.1	-	0.1
-	16/06/2022	-	1.3	(1.0)	(1.5)	(1.6)	2.6	-	(0.2)
1.0	TOTAL by K	-	1.6	(0.8)	(3.6)	(3.5)	5.7	0.1	0.5

Position post hedge in Meur

Spot	Vega	Rotation
115%	0.2	(0.1)
100%	0.1	0.0
93%	0.3	0.2
85%	0.4	0.4
75%	0.6	0.7
50%	2.5	1.4

Current Position in Meur

Spot	Vega	Rotation
115%	(0.2)	(0.1)
100%	(0.1)	(0.0)
93%	0.2	(0.0)
85%	0.2	(0.0)
75%	0.2	(0.0)
50%	(0.1)	(0.0)

CARRY due to hedge range 90%/110%

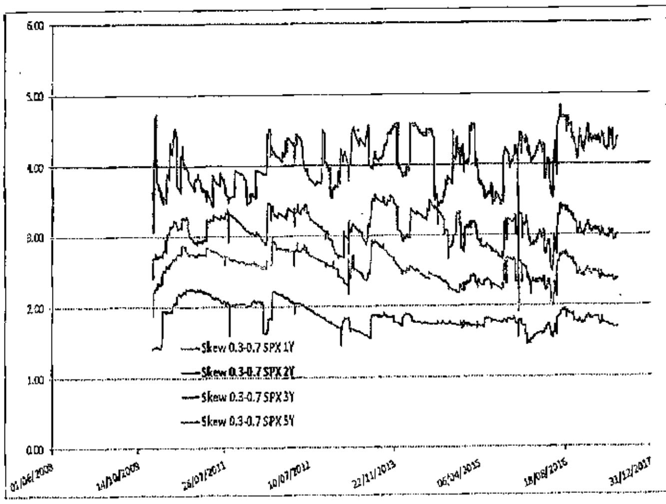
P&L vanna	3.6
Gamma Carry	0.1
TOTAL	3.69

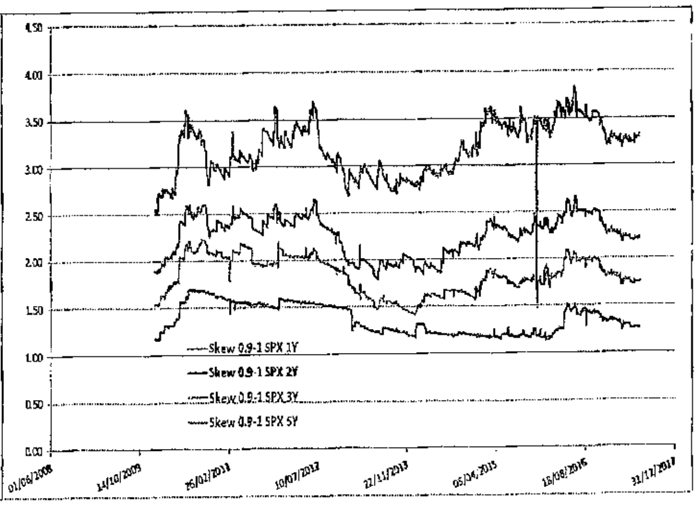
This hedge buys convexity 2Y and 5Y i.e. the skew between 30% and 70% strike. These convexities are quite cheap if we look at their percentiles (32% and 16%). On top of that, it sells near-the-money skew at a level which is not attractive in absolute value but which will provide a real good Vanna carry (3.7meur); it is important to say that it is a risky position but that could be quickly unwound in case of crisis, given the high liquidity of SPX vol market.

In short, buying SPX convexity is cheap and selling SPX skew is financing our strategies. The convexity will provide vega, rotation and voma to the position when the spot enters crisis zone below 60%

Percentile	Skew 0.3-0.7 SPX 1Y	Skew 0.3-0.7 SPX 2Y	Skew 0.3-0.7 SPX 3Y	Skew 0.3-0.7 SPX 5Y
10%	3.64	2.88	2.33	1.70
25%	3.91	3.01	2.38	1.70
50%	4.32	3.01	2.39	1.75
75%	4.39	3.22	2.63	1.88
90%	4.44	3.35	2.76	2.08
Last level	4.39	3.01	2.38	1.70
Last level percentile	81.4%	32.4%	24.3%	15.6%

Percentile	Skew 0.9-1 SPX 1Y	Skew 0.9-1 SPX 2Y	Skew 0.9-1 SPX 3Y	Skew 0.9-1 SPX 5Y
10%	2.86	1.96	1.60	1.19
25%	3.06	2.20	1.74	1.25
50%	3.33	2.22	1.75	1.27
75%	3.33	2.37	1.95	1.47
90%	3.48	2.49	2.06	1.56
Last level	3.33	2.22	1.75	1.27
Last level percentile	63.9%	37.9%	36.6%	41.4%





2. SX5E

Hedge proposal

VarSwaps in Meur	SX5E	Vega Vanilla in Meur 30.0%	45.0%	55.0%	75.0%	90.0%	100.0%	120.0%	TOTAL by T
-	16/09/2017	-	-	-	-	-	(0.2)	-	(0.2)
0.2	16/12/2017	-	-	-	-	0.3	(0.4)	(0.0)	0.1
1.0	16/06/2018	-	0.5	-	(2.1)	2.0	(1.0)	-	0.5
0.5	16/06/2019	0.6	-	(1.5)	(0.5)	-	0.8	-	(0.1)
2.0	16/06/2020	-	1.3	(1.2)	(4.3)	(1.3)	3.4	-	(0.1)
-	16/06/2022	-	-	-	-	-	-	-	-
3.7	TOTAL by K	0.6	1.8	(2.7)	(6.9)	1.1	2.7	(0.0)	0.2

Position post hedge in Meur

Spot	Vega	Rotation
115%	0.5	(0.2)
100%	0.1	(0.0)
93%	0.2	0.2
85%	1.1	0.7
75%	2.9	1.5
50%	4.7	4.2

Current Position in Meur

Spot	Vega	Rotation
115%	0.0	(0.0)
100%	0.2	0.0
93%	0.6	0.1
85%	1.6	0.2
75%	3.2	0.3
50%	0.5	(0.4)

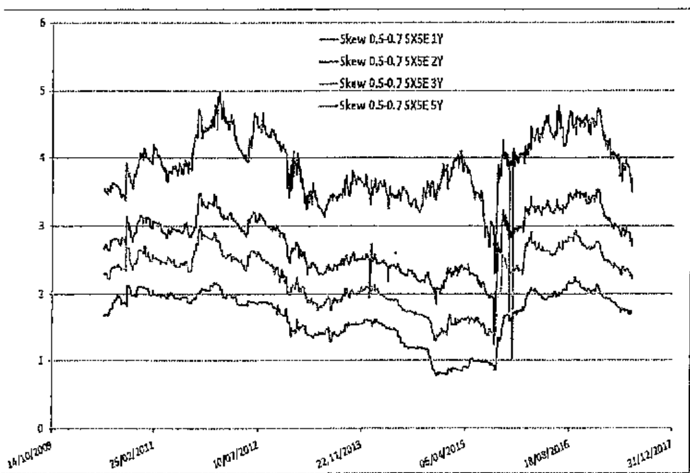
CARRY due to hedge range 90%/110%

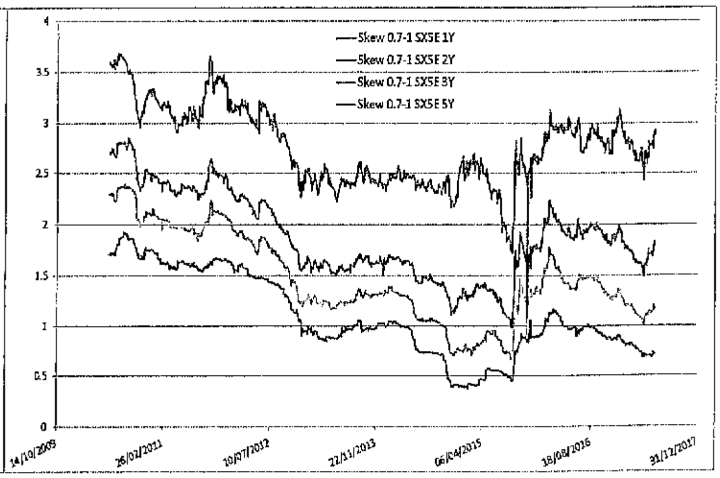
P&L vanna	1.0
Gamma Carry	(2.3)
TOTAL	(1.26)

We buy convexity at a median level and we sell skew at a quite low level to balance the Vanna and give a good carry. As for the SPX, convexity will provide vega, rotation and voma to the position when the spot enters crisis zone below 80%.

Percentile	Skew 0.5-0.7 SX5E 1Y	Skew 0.5-0.7 SX5E 2Y	Skew 0.5-0.7 SX5E 3Y	Skew 0.5-0.7 SX5E 5Y
10%	3.45	2.32	1.70	1.19
25%	3.50	2.62	2.09	1.58
50%	3.52	2.71	2.23	1.73
75%	4.02	2.97	2.46	1.89
90%	4.44	3.25	2.67	2.04
Last level	**3.50**	**2.71**	**2.23**	**1.73**
Last level percentile	21.1%	41.3%	41.7%	46.7%

Percentile	Skew 0.7-1 SX5E 1Y	Skew 0.7-1 SX5E 2Y	Skew 0.7-1 SX5E 3Y	Skew 0.7-1 SX5E 5Y
10%	2.39	1.44	1.05	0.71
25%	2.57	1.65	1.17	0.72
50%	2.90	1.80	1.17	0.79
75%	2.90	1.95	1.47	1.04
90%	3.16	2.37	2.00	1.62
Last level	**2.90**	**1.80**	**1.17**	**0.72**
Last level percentile	61.4%	51.1%	22.6%	16.0%





3. NKY

Hedge proposal

VarSwaps in Meur	NKY	Vega Vanilla in Meur 30.0%	50.0%	70.0%	75.0%	85.0%	100.0%	120.0%	TOTAL by T
-	16/09/2017	-	-	-	-	-	-	-	-
-	16/12/2017	-	-	-	-	-	-	-	-
-	16/06/2018	-	-	-	-	-	-	-	-
-	16/06/2019	-	-	-	-	-	-	-	-
-	16/06/2020	0.6	-	(0.5)	-	-	(1.4)	1.3	0.1
-	16/06/2022	-	-	-	-	-	-	-	-
-	TOTAL by K	0.6	-	(0.5)	-	-	(1.4)	1.3	0.1

Position post hedge in Meur

Spot	Vega	Rotation
115%	(0.3)	(0.9)
100%	(0.0)	(0.2)
93%	0.9	0.5
85%	1.8	1.1
75%	2.2	1.2
50%	2.0	1.1

Current Position in Meur

Spot	Vega	Rotation
115%	(0.8)	(1.0)
100%	(0.1)	(0.5)
93%	0.9	(0.0)
85%	1.7	0.3
75%	1.9	0.1
50%	0.4	0.2

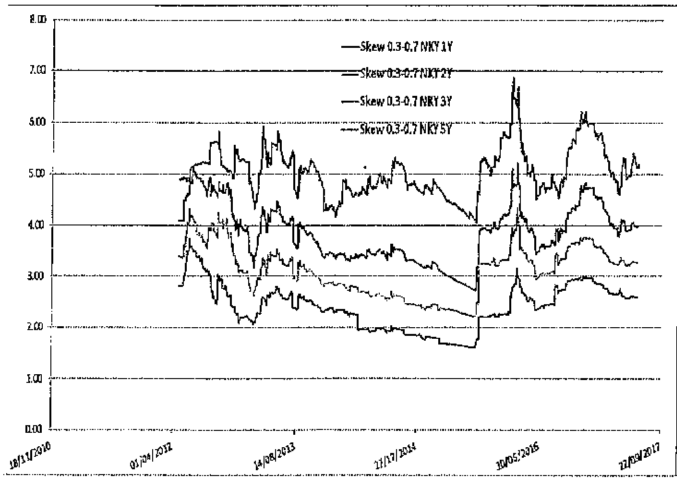
CARRY due to hedge range 90%/110%

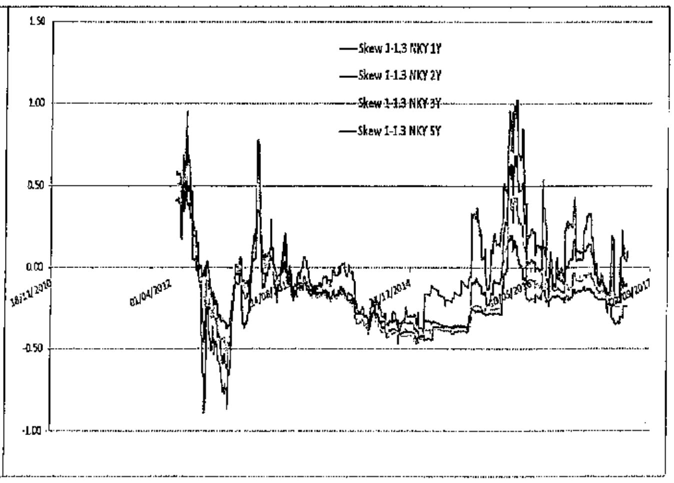
P&L vanna	0.8
Gamma Carry	(2.5)
TOTAL	(1.74)

The aim is to buy convexity (60% percentile) to hedge huge downside effects. Indeed, in 2000/2002, NKY was divided by 2 and the whole market began to be short vega when the spot crossed the downside barrier. The result was a sudden rise of volatility when spot touched 50%. The skew selling (around a median level) allows to reduce Vanna around the money.

Percentile	Skew 0.3-0.7 NKY 1Y	Skew 0.3-0.7 NKY 2Y	Skew 0.3-0.7 NKY 3Y	Skew 0.3-0.7 NKY 5Y
10%	4.68	3.39	2.61	1.96
25%	5.06	3.92	3.22	2.43
50%	5.19	4.00	3.28	2.59
75%	5.19	4.00	3.28	2.59
90%	5.35	4.31	3.51	2.75
Last level	5.19	4.00	3.28	2.59
Last level percentile	63.0%	61.7%	60.1%	65.2%

Percentile	Skew 1-1.3 NKY 1Y	Skew 1-1.3 NKY 2Y	Skew 1-1.3 NKY 3Y	Skew 1-1.3 NKY 5Y
10%	-0.25	-0.35	-0.38	-0.33
25%	-0.06	-0.12	-0.19	-0.24
50%	0.09	-0.10	-0.19	-0.24
75%	0.09	-0.10	-0.18	-0.20
90%	0.19	0.03	-0.05	-0.06
Last level	0.09	(0.10)	(0.19)	(0.24)
Last level percentile	71.3%	57.2%	46.6%	38.8%





4. HSCEI

Hedge proposal

VarSwaps in Meur	HSCEI	Vega Vanilla in Meur 30.0%	45.0%	55.0%	75.0%	85.0%	100.0%	130.0%	TOTAL by T
-	16/09/2017	-	-	-	-	-	-	-	-
-	16/12/2017	-	-	-	-	-	-	-	-
-	16/06/2018	-	-	-	-	-	-	-	-
-	16/06/2019	-	-	-	-	-	-	-	-
-	16/06/2020	-	0.7	(0.3)	(1.8)	0.6	0.7	-	(0.0)
-	16/06/2022	-	-	-	-	-	-	-	-
-	TOTAL by K	-	0.7	(0.3)	(1.8)	0.6	0.7	-	(0.0)

Position post hedge in Meur Spot	Vega	Rotation
115%	0.8	(0.7)
100%	0.2	(0.3)
93%	0.3	(0.1)
85%	0.6	0.1
75%	0.8	0.3
50%	0.5	0.5

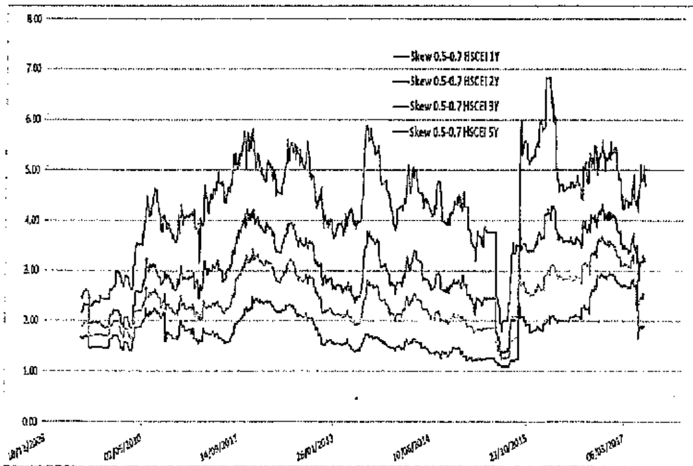
Current Position in Meur Spot	Vega	Rotation
115%	0.7	(0.6)
100%	0.3	(0.3)
93%	0.4	(0.1)
85%	0.8	(0.0)
75%	1.0	0.0
50%	0.3	0.1

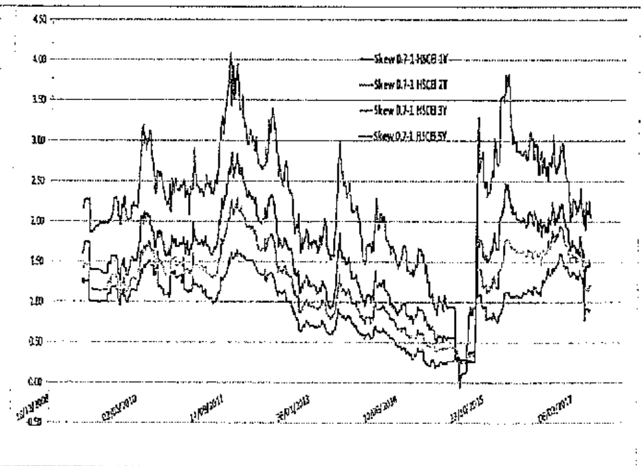
CARRY due to hedge range 90%/110%	
P&L vanna	0.8
Gamma Carry	(0.3)
TOTAL	0.46

Here, roughly, we put in place the same hedge as the one done for NKY.

Percentile	Skew 0.5-0.7 HSCEI 1Y	Skew 0.5-0.7 HSCEI 2Y	Skew 0.5-0.7 HSCEI 3Y	Skew 0.5-0.7 HSCEI 5Y
10%	3.48	2.32	1.86	1.39
25%	4.08	2.74	2.16	1.57
50%	4.69	3.19	2.52	1.90
75%	4.77	3.43	2.68	1.99
90%	5.33	3.85	3.12	2.29
Last level	4.69	3.19	2.52	1.90
Last level percentile	61.8%	58.6%	59.3%	62.1%

Percentile	Skew 0.7-1 HSCEI 1Y	Skew 0.7-1 HSCEI 2Y	Skew 0.7-1 HSCEI 3Y	Skew 0.7-1 HSCEI 5Y
10%	1.51	0.89	0.62	0.41
25%	2.00	1.35	1.10	0.79
50%	2.06	1.47	1.21	0.92
75%	2.57	1.76	1.48	1.15
90%	2.99	2.10	1.72	1.38
Last level	2.06	1.47	1.21	0.92
Last level percentile	36.8%	40.8%	44.9%	40.1%





5. HSI

Hedge proposal

VarSwaps in Meur	HIS	Vega Vanilla in Meur 30.0%	45.0%	55.0%	75.0%	85.0%	100.0%	120.0%	TOTAL by T
-	16/09/2017	-	-	-	-	-	-	-	-
-	16/12/2017	-	-	-	-	-	-	-	-
-	16/06/2018	-	-	0.2	(0.1)	(0.3)	(0.2)	-	(0.4)
-	16/06/2019	-	-	-	-	-	-	-	-
-	16/06/2020	-	0.5	(0.4)	-	-	-	-	0.1
-	16/06/2022	-	-	-	-	-	-	-	-
-	TOTAL by K	-	0.5	(0.2)	(0.1)	(0.3)	(0.2)	-	(0.3)

Position post hedge in Meur

Spot	Vega	Rotation
115%	(0.1)	(0.3)
100%	(0.4)	(0.1)
93%	(0.2)	0.1
85%	0.8	0.6
75%	3.0	1.2
50%	2.4	(0.2)

Current Position in Meur

Spot	Vega	Rotation
115%	0.1	(0.3)
100%	(0.1)	(0.3)
93%	0.0	(0.2)
85%	0.9	0.1
75%	2.6	0.5
50%	1.1	(0.2)

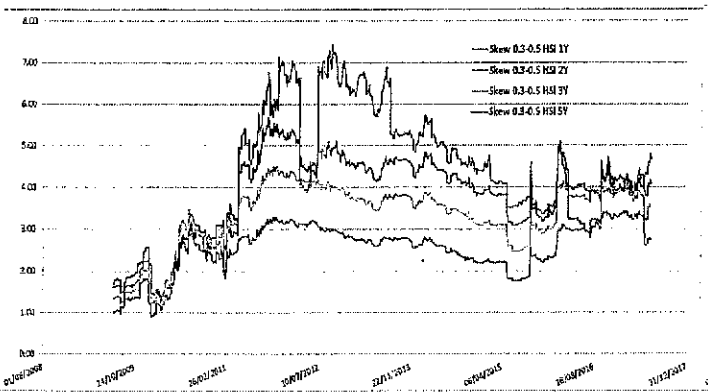
CARRY due to hedge range 90%/110%

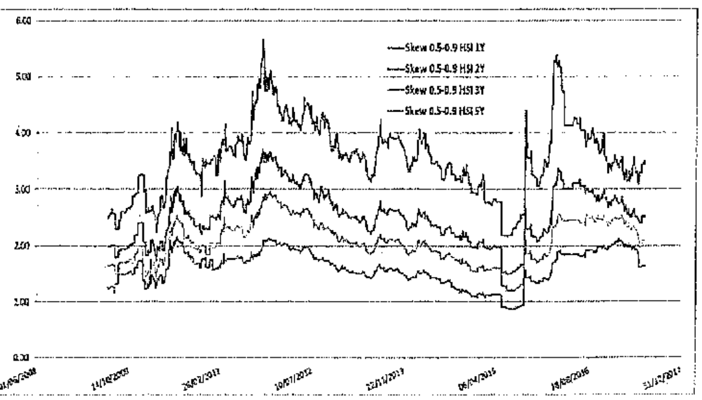
P&L vanna	(0.4)
Gamma Carry	(2.0)
TOTAL	(2.42)

Here we are buying convexity on 1Y and 3Y at a median level to reduce tail risk.

Percentile	Skew 0.3-0.5 HSI 1Y	Skew 0.3-0.5 HSI 2Y	Skew 0.3-0.5 HSI 3Y	Skew 0.3-0.5 HSI 5Y
10%	2.50	2.80	2.47	1.83
25%	3.53	3.81	3.12	2.42
50%	4.66	4.07	3.54	2.76
75%	4.98	4.42	3.78	2.84
90%	6.36	4.75	4.02	3.19
Last level	**4.66**	**4.07**	**3.54**	**2.76**
ıst level percenti	61.5%	48.4%	47.3%	53.5%

Percentile	Skew 0.5-0.9 HSI 1Y	Skew 0.5-0.9 HSI 2Y	Skew 0.5-0.9 HSI 3Y	Skew 0.5-0.9 HSI 5Y
10%	2.78	1.99	1.65	1.24
25%	3.32	2.34	1.90	1.50
50%	3.43	2.49	2.09	1.63
75%	3.81	2.75	2.31	1.78
90%	4.23	3.07	2.49	1.98
Last level	**3.43**	**2.49**	**2.09**	**1.63**
ıst level percenti	38.7%	44.9%	52.3%	52.7%





6. KOSPI2

Current Position in Meur						
Spot	**Vega Total**	**Rotation tot**	**Far Downside rotatio**	**Near Downside rotatio**	**Near Upside rotation**	**Far Upside rotation**
115%	(2.20)	0.20	(0.98)	0.67	0.40	0.10
100%	(0.01)	(0.11)	(0.10)	(0.43)	0.19	0.23
93%	(0.46)	(0.08)	0.17	(0.41)	(0.03)	0.19
85%	(0.14)	0.80	0.58	0.20	(0.16)	0.19
75%	2.11	1.89	0.19	1.18	0.33	0.18
50%	1.52	0.31	0.18	(0.25)	(0.30)	0.67

Current position is really short downside convexity and short downside skew, long upside skew with a reversed Vanna position. Offsetting these exposures would reduce risk but at very expensive levels. Indeed, Downside convexity level is at a 95% percentile (book is short). And upside is only at 32% (book is long). It seems not appropriate to clear this position, moreover, it would be expensive in terms of carry.

Percentile	Skew 0.5-0.7 KOSPI2 1Y	Skew 0.5-0.7 KOSPI2 2Y	Skew 0.5-0.7 KOSPI2 3Y	Skew 0.5-0.7 KOSPI2 5Y
10%	3.43	2.46	1.96	1.65
25%	3.86	2.77	2.25	1.85
50%	4.26	3.34	2.68	1.86
75%	4.26	3.34	2.68	1.86
90%	4.40	3.34	2.68	1.98
Last level	**4.26**	**3.34**	**2.68**	**1.86**
Last level percentile	72.5%	95.2%	82.2%	52.6%

Percentile	Skew 1-1.3 KOSPI2 1Y	Skew 1-1.3 KOSPI2 2Y	Skew 1-1.3 KOSPI2 3Y	Skew 1-1.3 KOSPI2 5Y
10%	-0.47	-0.16	-0.13	0.01
25%	-0.47	-0.06	0.02	0.08
50%	-0.47	-0.06	0.02	0.08
75%	-0.02	0.04	0.08	0.18
90%	0.29	0.27	0.28	0.28
Last level	**-0.47**	**-0.06**	**0.02**	**0.08**
Last level percentile	5.5%	26.7%	32.0%	30.4%